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UTILITY PATENT APPLICATION TRANSMITTAL <small>(Only for new nonprovisional applications under 37 CFR 1.53(b))</small>	Attorney Docket No.	0557-4784-2
	First Inventor or Application Identifier	Wataru NARA
	Title	IMAGE READING APPARATUS

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APPLICATION ELEMENTS <i>See MPEP chapter 600 concerning utility patent application contents</i>	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231
1. <input checked="" type="checkbox"/> Fee Transmittal Form (e.g. PTO/SB/17) (Submit an original and a duplicate for fee processing) 2. <input checked="" type="checkbox"/> Specification Total Pages 43 3. <input checked="" type="checkbox"/> Drawing(s) (35 U.S.C. 113) Total Sheets 6 4. <input type="checkbox"/> Oath or Declaration Total Pages <input type="text"/> a. <input type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> Copy from a prior application (37 C.F.R. §1.63(d)) (for continuation/divisional with box 15 completed) i. <input type="checkbox"/> DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §1.63(d)(2) and 1.33(b). 5. <input type="checkbox"/> Incorporation By Reference (usable if box 4B is checked) The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4B, is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein.	ACCOMPANYING APPLICATION PARTS 6. <input type="checkbox"/> Assignment Papers (cover sheet & document(s)) 7. <input type="checkbox"/> 37 C.F.R. §3.73(b) Statement <input type="checkbox"/> Power of Attorney (when there is an assignee) 8. <input type="checkbox"/> English Translation Document (if applicable) 9. <input checked="" type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input checked="" type="checkbox"/> Copies of IDS Citations (3) 10. <input type="checkbox"/> Preliminary Amendment 11. <input checked="" type="checkbox"/> White Advance Serial No. Postcard 12. <input type="checkbox"/> Small Entity Statement(s) <input type="checkbox"/> Statement filed in prior application. Status still proper and desired. 13. <input checked="" type="checkbox"/> Certified Copy of Priority Document(s) (1) (if foreign priority is claimed) 14. <input checked="" type="checkbox"/> Other: Notice of Priority, List of Inventor's Name and Address
15. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below. <input type="checkbox"/> Continuation <input type="checkbox"/> Divisional <input type="checkbox"/> Continuation-in-part (CIP) of prior application no.: Prior application information: Examiner: Group Art Unit:	
16. Amend the specification by inserting before the first line the sentence: <input type="checkbox"/> This application is a <input type="checkbox"/> Continuation <input type="checkbox"/> Division <input type="checkbox"/> Continuation-in-part (CIP) of application Serial No. Filed on <input type="checkbox"/> This application claims priority of provisional application Serial No. Filed	
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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, WATARU NARA, a
citizen of Japan residing at Kanagawa, Japan have
invented certain new and useful improvements in

IMAGE READING APPARATUS

of which the following is a specification:-

1 BACKGROUND OF THE INVENTION

1. Field of the Invention

 The present invention relates to an image
reading apparatus which uses a photoelectric device
5 such as a charge-coupled device (CCD) or the like, and
generates an image signal from an original image, and,
in particular, to an image reading apparatus which
performs correction, using data of a black reference
level, on image data obtained from the original image
10 through the photoelectric device.

2. Description of the Related Art

 An image reading apparatus in the related
art, which apparatus uses a photoelectric device such
15 as a charge-coupled device (CCD) or the like, and
generates an electric image signal from an original
image, performs a correction, using data of a black
reference level, on image data obtained from the
original image through the photoelectric device. The
20 method thereof will now be described.

 Generally speaking, an image signal
outputted from a CCD includes a signal component due
to a dark current which does not change due to change
in an amount of light received by the CCD, and a
25 signal component which changes in accordance with the

1 change in the amount of light received by the CCD. A
signal component which is effective for image
processing is only the signal component which changes
in accordance with the change in the amount of light
5 received by the CCD. Accordingly, in order to obtain
the signal component which is to be outputted to a
following image processing circuit, it is necessary to
perform the correction (black shading correction) to
subtract the data of the signal component due to the
10 dark current from the data of the image signal
outputted from the CCD.

The signal component due to the dark current
can be obtained as a result of outputs of an optical
black (OPB) portion provided as part of a line of
15 photoelectric sensors of the CCD (scan beginning part
in a main scan direction, as shown in FIG. 1) being
averaged, before the CCD reads the original image, for
each line, for example. The OPB portion provided as
the part of the line of the photoelectric sensors of
20 the CCD is obtained as follows: Aluminum deposition
is performed on several (for example, eight, sixteen,
or the like) photoelectric sensors of the line of the
(for example, thousands of) photoelectric sensors of
the CCD, each photoelectric sensor corresponding to a
25 pixel, which several photoelectric sensors are

1 arranged at the end at which scanning in the main scan
direction begins. Thereby, these several
photoelectric sensors of the CCD are covered by the
aluminum film, and, as a result, are shielded from
5 light, and, thus, no light is received by these
several photoelectric sensors of the CCD. Thereby,
the data of the black reference level can be obtained
using the data obtained from the several photoelectric
sensors of the OPB portion of the CCD.

10 FIG. 2 is a block diagram showing essential
portions of one example of an image reading apparatus
including a black shading correction portion for
performing the above-mentioned correction (black
shading correction) in the related art.

15 The image reading apparatus shown in FIG. 2
includes a CCD portion 1 which comprises a CCD
including a line of photoelectric sensors extending in
the main scan direction, and generates an image signal
from an original image as a result of reading the
20 original image. The reading of the original image is
performed as follows: The CCD portion 1 scans a first
line of the original image in the main scan direction
along the line of the photoelectric sensors of the CCD
(whereby image data of the first line is obtained) and
25 scans the original image in the sub-scan direction

1 (perpendicular to the main scan direction) by
sequentially scanning subsequent lines of the original
image (whereby image data of respective lines, i.e., a
second line, a third line, ..., an n-th line, is
5 obtained in sequence). The CCD of the CCD portion 1
is the same as the above-described CCD having the OPB
portion. The image reading apparatus further includes
a signal processing portion 2 which performs
processing of an analog image signal outputted from
10 the CCD portion 1, an A-D converting portion 3 which
is an A-D converter converting the analog image signal
into a digital image signal, a peak hold (P/H) portion
4 for detecting a background level of the original
image, a black shading correction portion 5 which
15 performs the correction, using the data of the black
reference level, on the image signal, and a white
shading correction portion 6 which performs white
shading correction on the image signal. Further, the
black shading correction portion 5 includes an
20 average-value calculating circuit 7 which calculates
the average of the outputs of the CCD portion 1 during
the period during which the CCD portion 1 obtains data
(to be used for obtaining the black reference level)
through the photoelectric sensors of the above-
25 mentioned OPB portion of the CCD, and a subtracter 8

1 which subtracts the average calculated by the average-
value calculating circuit from the data of the image
signal obtained from the original image.

5 In FIG. 2, the image analog signal outputted
by the CCD portion 1 undergoes signal processing
through the signal processing portion 2, and, then, is
converted into the digital image signal by the A-D
converting portion 3. The digital image signal
outputted from the A-D converting portion 3 is
10 inputted to the black shading correction portion 5,
undergoes the black shading correction therethrough,
and, then, is outputted. The image signal outputted
from the black shading correction portion 5 is
inputted to the white shading correction portion 6.
15 The white shading correction portion 6 performs the
white shading correction on the data of the thus-
inputted image signal using white reference data which
was obtained using a white reference plate or the
like. Then, the image signal is inputted to an image
20 processing block (not shown in the figure).

25 In the black shading correction portion 5,
the average calculating circuit 7 calculates the
average of the outputs from the OPB portion in the CCD
portion 1 as the data of the reference black level at
the beginning of reading of an original image for each

1 line, and outputs the thus-calculated average Dopb
(the average of the pixel values (of the OPB portion)
in the main scan direction). The subtracter 8, which
has received the average Dopb, subtracts the average
5 Dopb from the data D0 of the image signal (outputted
from the A-D converting portion 3 when the original
image is read), and outputs the thus-obtained data to
the white shading correction portion 6. Thus, the
black shading correction portion 5 averages the data
10 outputted from the OPB portion of the CCD portion 1
for each line, and, thereby, obtains the data of the
black reference level to be used for the black shading
correction to eliminate the black offset from the
image signal. The calculation of the average
15 performed by the average calculating circuit 7 is
performed only during the period during which the
average calculating circuit receives an OPBGATE
signal, which is provided to the average calculating
circuit 7 only during the period during which data
20 obtained from the OPB portion in the CCD portion 1 is
outputted from the CCD portion 1.

As shown in FIG. 2, the peak hold (P/H)
portion 4 is connected between the signal processing
portion 2 and the A-D converting portion 3. The peak
25 hold portion 4 holds the peak value of the output from

1 the signal processing portion 2, and provides the peak
value to the A-D converting portion 3 as the reference
voltage of the A-D converting portion 3. Thus, the
peak hold portion 4 detects the color level of the
5 background of the original image, and provides the
thus-detected level to the A-D converting portion 3 as
the reference voltage. Thereby, the influence of the
color of the background of the original image on the
image signal outputted from the A-D converting portion
10 3 is eliminated.

The peak value of the image signal varies
due to variation in the color of the background of the
original image. In many cases, the original image
read by the image reading apparatus is an image
15 printed on a paper sheet. In such a case, the above-
mentioned color of the background of the original
image is the color of this paper sheet. The color of
the paper sheet on which the original image was
printed is ordinarily white. However, there is a case
20 where the color of the paper sheet on which the
original image was printed is not white, but is red,
for example. Therefore, the peak value of the image
signal varies as the color of the paper sheet on which
the original image was printed varies. As a result,
25 the output of the peak hold portion 4 varies, and,

1 accordingly, the reference voltage of the A-D
converting portion 3 varies. Thereby, the output from
the A-D converting portion 3 varies. As a result, the
level of the black offset which should be eliminated
5 from the image signal through the black shading
correction performed by the black shading correction
portion 5 varies. Therefore, the black shading
correction to eliminate the black offset from the
image signal performed by the black shading portion 5
10 should be performed at the same time (in real time)
the image signal obtained when the background of the
original image is read is processed.

However, the number of the photoelectric
sensors of the CCD which can be used as the OPB
15 portion is limited, because almost all of the
photoelectric sensors are used for reading the
original image and the photoelectric sensors used as
the OPB portion cannot be used for reading the
original image. Therefore, when the signal-to-noise
20 ratio (S/N ratio) of the image reading apparatus is
bad, variation in the average of the outputs of the
photoelectric sensors of the OPB portion occurs due to
the noise. Thereby, the black reference level used
for the black shading correction may vary for each
25 line due to the noise. When the black reference level

1 varies for each line due to the noise, the following
situation occurs: Although the black offset level of
the original image does not vary or varies smoothly in
the sub-scan direction, a pattern of lateral stripes
5 develops in the image represented by the image signal,
because the black reference level used for the black
shading correction varies for each line due to the
noise, and, thereby, the level of the image signal
obtained through the black shading correction varies
10 for each line.

SUMMARY OF THE INVENTION

The present invention has been devised in
order to solve the above-described problem, and an
15 object of the present invention is to provide an image
reading apparatus by which the black shading
correction to eliminate the black offset can be
performed at the same time (in real time) the image
signal obtained when the background level of the
20 original image is read is processed, and, also,
variation in the average of outputs of the OPB portion
for each line can be controlled.

An image reading apparatus, according to the
present invention, comprises:

25 photoelectrically converting means for

1 photoelectrically converting image information
obtained from optically reading an original image,
line by line, and outputting an image signal, the
photoelectrically converting means having optically
5 shielding means provided at a portion thereof; and
black shading correction means for
correcting the image signal using a black reference
level, the black reference level being obtained from
the portion of the photoelectrically converting means
10 for each line during an operation of the reading of
the original image,

wherein the black reference level used by
the black shading correction means for each line is
obtained using black reference values, each of the
15 black reference values being data of the portion of
the photoelectrically converting means for a
respective one of a plurality of lines.

In this arrangement, the black reference
level used by said black shading correction means for
20 each line is obtained using black reference values,
each of the black reference values being data of the
portion of the photoelectrically converting means for
a respective one of a plurality of lines. Thereby, it
is possible to control the variation in the level of
25 the image signal for each line due to the variation in

1 the black reference level used by the black shading
correction means for each line due to noise.

The black reference level may be a weighted
average of the black reference values.

5 Thereby, it is possible to control the
variation in the level of the image signal for each
line due to the variation in the black reference level
used by the black shading correction means for each
line due to noise, and, also, it is possible to enable
10 the correction performed by the black shading
correction means to well follow the variation in the
black offset level of the image signal due to
variation in the level of the image signal, for each
line, by appropriately selecting the above-mentioned
15 plurality of lines and appropriately determining the
coefficient of the weighted-averaging.

The black reference value for a respective
line may be an average of pixel values in a main scan
direction, and the weighted average of the black
20 reference values is obtained from weighted-averaging,
in a sub-scan direction, the black reference values.

The black reference level for each line may
be obtained from weighted-averaging the black
reference value for the current line and the black
25 reference level for the preceding line.

1 In this arrangement, it is possible to
enable the correction performed by the black shading
correction means to well follow the variation in the
black offset level of the image signal due to
5 variation in the level of the image signal, for each
line, and, also, it is possible to reduce the size of
the arrangement of the black shading correction means.

The black reference level may be a moving
average of the black reference values.

10 In this arrangement, it is possible to
simplify the arrangement of the black shading
correction means.

The black reference value for a respective
line may be an average of pixel values in a main scan
15 direction, the moving average being obtained from
moving-averaging, in a sub-scan direction, the black
reference values.

The black reference level for each line may
be obtained from moving-averaging the black reference
20 values for the plurality of lines.

The plurality of lines may comprise the
current line and preceding lines.

In this arrangement, it is possible to
enable the correction performed by the black shading
25 correction means to well follow the variation in the

1 black offset level of the image signal due to
variation in the level of the image signal, for each
line.

Other objects and further features of the
5 present invention will become more apparent from the
following detailed description when read in
conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

10 FIG. 1 shows an arrangement of photoelectric
sensors of a CCD used for reading an original image in
an image reading apparatus in each of the related art,
and first and second embodiments of the present
invention;

15 FIG. 2 is a block diagram showing essential
portions of an image reading apparatus in the related
art;

FIG. 3 is a block diagram showing essential
portions of an image reading apparatus in the first
20 embodiment of the present invention;

FIG. 4 is a block diagram showing an
internal arrangement of a black shading correction
portion shown in FIG. 3;

FIG. 5 is a block diagram showing essential
25 portions of an image reading apparatus in the second

1 embodiment of the present invention; and

FIG. 6 is a block diagram showing an internal arrangement of a black shading correction portion shown in FIG. 5.

5

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will now be described.

FIG. 3 is a block diagram showing essential
10 portions of an image reading apparatus, in a first embodiment of the present invention, including a black shading correction portion, which performs the black shading correction.

As shown in FIG. 3, the image reading
15 apparatus in the first embodiment includes a CCD portion 1 which comprises a CCD including a line of photoelectric sensors extending in the main scan direction, and generates an image signal as a result of reading an original image. The reading of the
20 original image is performed as follows: The CCD portion 1 scans a first line of the original image in the main scan direction along the line of the photoelectric sensors of the CCD (whereby image data of a first line is obtained) and scans the original
25 image in the sub-scan direction (perpendicular to the

1 main scan direction) by sequentially scanning
subsequent lines of the original image (whereby image
data of respective lines, i.e., a second line, a third
line, ..., an n-th line, is obtained in sequence).

5 The CCD of the CCD portion 1 is the same as the above-
described CCD having the OPB portion. The image
reading apparatus further includes a signal processing
portion 2 which performs processing of an analog image
signal outputted from the CCD portion 1, an A-D
10 converting portion 3 which is an A-D converter
converting the analog image signal into a digital
image signal, a peak hold (P/H) portion 4 for
detecting a background level of the original image, a
black shading correction portion 15 which performs a
15 black shading correction, using the data of the black
reference level, on the image signal, and a white
shading correction portion 6 which performs a white
shading correction on the image signal.

The arrangement of the image reading
20 apparatus in the first embodiment is the same as the
image reading apparatus in the related art shown in
FIG. 2, except for the black shading correction
portion 15. That is, each of the portions 1, 2, 3, 4
and 6 of the image reading apparatus in the first
25 embodiment is the same as a respective one of the

1 portions 1, 2, 3, 4 and 6 in the related art shown in
FIG. 2.

The black shading correction portion 15
includes an average calculating circuit 17 which
5 calculates the average of outputs of the CCD portion 1
during the period during which the CCD portion 1
outputs data obtained through the photoelectric
sensors of the above-mentioned OPB portion of the CCD,
a weighted-average circuit 19 which performs weighted-
10 averaging using values outputted from the average
calculating circuit 17, and a subtracter 18 which
subtracts the value calculated by the weighted-average
circuit 19 from the data of the image signal outputted
from the A-D converting circuit 3.

15 In FIG. 3, the analog image signal outputted
by the CCD portion 1 undergoes signal processing
through the signal processing portion 2, and, then, is
converted into the digital image signal by the A-D
converting portion 3. The digital image signal
20 outputted from the A-D converting portion 3 is
inputted to the black shading correction portion 15,
undergoes the black shading correction therethrough,
and, then, is outputted. The image signal outputted
from the black shading correction portion 15 is
25 inputted to the white shading correction portion 6.

1 The white shading correction portion 6 performs the
white shading correction of the data of the thus-
inputted image signal using white reference data which
was obtained using a white reference plate or the
5 like. Then, the image signal is inputted to an image
processing block (not shown in the figure).

 The average calculating circuit 17 of the
black shading correction portion 15 obtains outputs of
the OPB portion of the CCD portion 1 (from the CCD
10 portion 1 via the signal processing portion 2 and A-D
converting portion 3) before the CCD portion 1 reads
the original image, for each line. Then, the average
calculating circuit 17 calculates the average of these
outputs, and outputs the average as Dopb. The
15 weighted-average circuit 19, which receives the
average Dopb, calculates a weighted average Db,n (data
of a black reference level) using the average Dopb,
and outputs the calculated weighted average Db,n to
the subtracter 18. The weighted average Db,n results
20 from a weighted-average calculation being repeated for
each line from the second line to the current line,
the weighted-average calculation using the average
 $Dopb,1$ for the first line through the average $Dopb,n$
for the current line. The subtracter 18, which has
25 received the weighted average Db,n , subtracts the

1 weighted average $D_{b,n}$ from the data D_0 of the image
signal (outputted from the A-D converting portion 3
when the original image is read), and outputs the
thus-obtained data to the white shading correction
5 portion 6. The calculation of the average performed
by the average calculating circuit 17 is performed
only during the period during which the average
calculating circuit 17 receives the OPBGATE signal,
which is provided to the average calculating circuit
10 17 only during the period during which the data
obtained from the OPB portion of the CCD portion 1 is
outputted from the CCD portion 1.

Further, in the arrangement of the first
embodiment shown in FIG. 3, as in the related art
15 shown in FIG. 2, the peak hold (P/H) portion 4 is
connected between the signal processing portion 2 and
the A-D converting portion 3. The peak hold portion 4
holds the peak value of the output from the signal
processing portion 2, and provides the peak value to
20 the A-D converting portion 3 as the reference voltage
of the A-D converting portion 3. Because the
operation of the peak hold circuit 4 in the first
embodiment is the same as the operation of the peak
hold circuit 4 in the related art shown in FIG. 2,
25 further description is omitted.

1 As described above, in the black shading
correction portion 15 in the first embodiment, the
data of the black reference level for eliminating the
black offset from the image signal is obtained as a
5 result of performing weighted-averaging using the
average of the data obtained from the data outputted
from the OPB portion of the CCD of the CCD portion 1
for the first line through the average of the data
obtained from the data outputted from the OPB portion
10 of the CCD of the CCD portion for the current line in
sequence. In this case, the weighted average Db,n is
obtained from the following equation (1), for example:

$$15 \quad Db,n = Dopb,n / A + Db,n-1 \times (A-1) / A \quad \dots (1)$$

where:

' Db,n ' represents the data of the black
reference level (which is subtracted from the data $D0$
of the image signal through the subtracter 18) for the
20 n -th line;

' $Db,n-1$ ' represents the data of the black
reference level (which is subtracted from the data $D0$
of the image signal through the subtracter 18) for the
($n-1$)-th line;

25 ' $Dopb,n$ ' represents the average or a

1 weighted average of the data obtained from the data
outputted from the OPB portion for the n-th line (that
is, the average or a weighted average of the data of
the image signal outputted from the A-D converting
5 portion 3 during the period during which the data
obtained from the OPB portion of the CCD portion 1 is
outputted from the CCD portion 1 before the original
image is read for the n-th line); and

'A' represents a constant (weighted-average
10 coefficient).

However, when the image data for the first
line is processed, that is, when $n = 1$,

$$D_{b,1} = D_{opb,1}$$

15

Assuming that the S/N ratio of the image
reading apparatus is bad, and, thereby, the average
 $D_{opb,n}$ of the data obtained from the data outputted
from the OPB portion for each line varies, the average

20 $D_{opb,n}$ is expressed as follows:

$$D_{opb,n} = D_{b,n-1} + \alpha \dots (2)$$

where α represents the variation due to the
25 noise.

1 As a result of substitution of the equation
(2) in the equation (1), the following equation (3) is
obtained:

5 $Db,n = Db,n-1 + \alpha / A \quad \dots (3)$

From the equation (3), it can be seen that,
by performing the weighted-averaging as in the first
embodiment of the present invention, the variation α
10 due to the noise is reduced by a factor of A.

FIG. 4 is a block diagram showing the
internal arrangement of the weighted-average circuit
19.

The weighted-average circuit 19 includes a
15 multiplier 21 which multiplies the weighted average
 $Db,n-1$ for the preceding line, outputted from the
weighted-average circuit 19, by $(A - 1)$, an adder 20
which adds the value outputted from the multiplier 21
to the average $Dopb,n$, provided by the average
20 calculating circuit 17, and a divider 22 which divides
the value outputted from the adder 20 by A so as to
output the weighted average Db,n (the data of the
black reference level which is subtracted from the
data D0 of the image signal through the subtracter
25 18). However, when the image data for the first line

1 is processed, that is, when $n = 1$, the weighted-
average circuit 19 outputs the inputted average
Dopb,1, as it is, as the data Db,1 of the black
reference level (which is subtracted from the data D0
5 of the image signal through the subtracter 18) for the
first line.

In the arrangement shown by the block
diagrams of FIGS. 3 and 4, the value obtained as a
result of weighted-averaging shown in the above-
10 mentioned equation (1) being performed is outputted to
the subtracter 18. Accordingly, as shown in the
above-mentioned equation (3), it is possible to reduce
the variation due to the noise by the factor of A.

Thus, by using the weighted-average circuit
15 19, it is possible to take measures to deal with the
situation that the S/N ratio of the image reading
apparatus is bad, using the very simple arrangement at
a low cost.

Further, as a feature of the weighted-
20 average circuit, as shown in the above-mentioned
equation (1), the data Db,n of the black reference
level for the current line is affected by the average
Dopb,n for the current line most greatly. Thereby, by
using the weighted-average circuit, it is possible
25 that the black shading correction well follows the

1 variation in the black offset level.

In a case where the above-described weighted-average circuit 19 is formed by hardware, the calculation can be performed only by shifting of the register values when the constant A used in the above-mentioned equation (1) is determined to be a power of two (for example, 2, 4, 8 or the like). Thereby, it is possible to simplify the arrangement of the hardware.

10 Instead of performing the weighted-average calculation as in the first embodiment, it is also possible to perform a moving-average calculation using the average $Dopb, n-m$ for the $(n - m)$ -th line (m -th previous line) through the average $Dopb, n$ for the n -th line (current line). Also in this case, it is possible to reduce the influence due to a bad S/N ratio of the image reading apparatus on the black reference level used for the black shading correction.

FIG. 5 is a block diagram showing essential portions of an image reading apparatus, in a second embodiment of the present invention, including a black shading correction portion, which performs the black shading correction using the data of the black reference level obtained as a result of performing the above-mentioned moving-average calculation.

1 As shown in FIG. 5, the image reading
apparatus in the second embodiment includes a CCD
portion 1 which comprises a CCD including a line of
photoelectric sensors extending in the main scan
5 direction, and generates an image signal as a result
of reading an original image. The reading of the
original image is performed as follows: The CCD
portion 1 scans a first line of the original image in
the main scan direction along the line of the
10 photoelectric sensors of the CCD (whereby image data
of the first line is obtained) and scans the original
image in the sub-scan direction (perpendicular to the
main scan direction) by sequentially scanning
subsequent lines of the original image (whereby image
15 data of respective lines, i.e., a second line, a third
line, ..., an n-th line, is obtained in sequence).
The CCD of the CCD portion 1 is the same as the above-
described CCD having the OPB portion. The image
reading apparatus further includes a signal processing
20 portion 2 which performs processing of an analog image
signal outputted from the CCD portion 1, an A-D
converting portion 3 which is an A-D converter
converting the analog image signal into a digital
image signal, a peak hold (P/H) portion 4 for
25 detecting the background level of the original image,

1 a black shading correction portion 25 which performs a
black shading correction, using the data of the black
reference level, on the image signal, and a white
shading correction portion 6 which performs a white
5 shading correction on the image signal.

The arrangement of the image reading
apparatus in the second embodiment is the same as the
image reading apparatus in the first embodiment shown
in FIG. 3, except for the black shading correction
10 portion 25. That is, each of the portions 1, 2, 3, 4
and 6 of the image reading apparatus in the second
embodiment is the same as a respective one of the
portions 1, 2, 3, 4 and 6 in the first embodiment
shown in FIG. 3.

15 The black shading correction portion 25
includes an average calculating circuit 17 which
calculates the average Dopb of the outputs of the CCD
portion 1 (obtained via the signal processing portion
2 and A-D converting portion 3) during the period
20 during which the CCD portion 1 obtains data through
the photoelectric sensors of the above-mentioned OPB
portion of the CCD, a moving-average circuit 29 which
performs moving-averaging using values outputted from
the average calculating circuit 17, and a subtracter
25 18 which subtracts the moving average Db thus

1 calculated by the moving-average circuit 19 from the
data D0 of the image signal outputted from the A-D
converting circuit 3 when the original image is read.

5 In FIG. 5, the analog image signal outputted
by the CCD portion 1 undergoes signal processing by
the signal processing portion 2, and, then, is
converted into the digital image signal by the A-D
converting portion 3. The digital image signal
outputted from the A-D converting portion 3 is
10 inputted to the black shading correction portion 25,
undergoes the black shading correction therethrough,
and, then, is outputted. The image signal outputted
from the black shading correction portion 25 is
inputted to the white shading correction portion 6.
15 The white shading correction portion 6 performs the
white shading correction of the data of the thus-
inputted image signal using the white reference data
which was obtained using a white reference plate or
the like. Then, the image signal is inputted to an
20 image processing block (not shown in the figure).

25 The average calculating circuit 17 of the
black shading correction portion 25 calculates the
average of outputs of the OPB portion of the CCD
portion 1 (obtained from the CCD portion 1 via the
signal processing portion 2 and A-D converting portion

1 3) before the CCD portion 1 reads the original image,
for each line. Then, the average calculating circuit
17 outputs the thus-calculated average Dopb. The
moving-average circuit 29, which receives the average
5 Dopb, calculates a moving average Db,n (the average,
in the sub-scan direction, of $(m + 1)$ averages, each
of which averages is the average in the main scan
direction) and outputs the moving average Db,n to the
subtractor 18. The moving average Db,n is obtained as
10 a result of a moving-average calculation being
performed using the average Dopb,n-m for the $(n - m)$ -
th line (m-th previous line) through the average
Dopb,n for the n-th line (current line). The
subtractor 18, which has received the moving average
15 Db,n, subtracts the moving average Db,n from the data
D0 of the image signal outputted from the A-D
converting portion 3 when the original image is read,
and outputs the thus-obtained data to the white
shading correction portion 6. The calculation of the
20 average performed by the average calculating circuit
17 is performed only during the period during which
the average calculating circuit 17 receives the
OPBGATE signal which is provided to the average
calculating circuit 17 only during the period during
25 which the data obtained from the OPB portion of the

1 CCD portion 1 is outputted from the CCD portion 1.

Further, in the arrangement of the second embodiment shown in FIG. 5, as in the first embodiment shown in FIG. 3, the peak hold (P/H) portion 4 is
5 connected between the signal processing portion 2 and the A-D converting portion 3. The peak hold portion 4 holds the peak value of the output from the signal processing portion 2, and provides the peak value to the A-D converting portion 3 as the reference voltage
10 of the A-D converting portion 3. Because the operation of the peak hold circuit 4 in the second embodiment is the same as the operation of the peak hold circuit 4 in the first embodiment shown in FIG. 3, further description is omitted.

15 As described above, in the black shading correction portion 25 in the second embodiment, the data of the black reference level for eliminating the black offset from the image signal is obtained as a result of performing moving-averaging using the
20 average of the data obtained from the data outputted from the OPB portion of the CCD of the CCD portion 1 for the $(n - m)$ -th line (m -th previous line) through the average of the data obtained from the data outputted from the OPB portion of the CCD of the CCD
25 portion 1 for the n -th line (current line). In this

1 case, the moving average Db,n is obtained from the
following equation (4), for example:

$$Db,n = \Sigma Dopb,x (n - m, n) / (m + 1) \quad \dots$$

5 (4)

where:

' Db,n ' represents the value of the black
reference level (which is subtracted from the data $D0$
10 of the image signal through the subtracter 18) for the
 n -th line;

' $\Sigma Dopb,x (n - m, n)$ ' represents the sum of
the $Dopb,x$ for $x = n - m$ through n , that is, the sum
of $Dopb,n-m$ through $Dopb,n$; and

15 ' $Dopb,x$ ' represents the average or a
weighted average of the data obtained from the data
outputted from the OPB portion for the x -th line (that
is, the average or a weighted average of the data of
the image signal outputted from the A-D converting
20 portion 3 during the period during which the data
obtained from the OPB portion of the CCD portion 1 is
outputted from the CCD portion 1 before the original
image is read for the x -th line).

However, when $1 < n \leq m$,

25

1 $Db, n = \Sigma Dopb, x (1, n) / n$

 where ' $\Sigma Dopb, x (1, n)$ ' represents the sum of
the $Dopb, x$ for $x = 1$ through n , that is, the sum of
5 $Dopb, 1$ through $Dopb, n$.

 When $n = 1$,

$Db, 1 = Dopb, 1$

10 FIG. 6 is a block diagram showing the
internal arrangement of the moving-average circuit 29.

 As shown in FIG. 6, the moving-average
circuit 29 includes a latch circuit 30 which latches
the average $Dopb, n-m$ for the $(n - m)$ -th line through
15 the average $Dopb, n-1$ for the $(n - 1)$ -th line, which
were already outputted from the average calculating
circuit 17 in sequence, and outputs the thus-latched
values in parallel. The moving-average circuit 29
further includes an average calculating circuit 31
20 which calculates the sum of the average $Dopb, n$ for the
 n -th line (current line), outputted from the average
calculating circuit 17 and the average $Dopb, n-m$ for
the $(n - m)$ -th line through the average $Dopb, n-1$ for
the $(n - 1)$ -th line, outputted from the latch circuit
25 30. Then, the average calculating circuit 30 divides

1 the thus-obtained sum by $(m + 1)$, that is, by the
total number of the averages $Dopb, n-m$ through $Dopb, n$
inputted to the average calculating circuit 30.

However, when $1 < n \leq m$, the latch circuit
5 30 latches the average $Dopb, 1$ for the first line
through the average $Dopb, n-1$ for the $(n - 1)$ -th line,
already outputted from the average calculating circuit
17 in sequence, and outputs the thus-latched values in
parallel. The average calculating circuit 31
10 calculates the sum of the average $Dopb, n$ for the n -th
line (current line), outputted from the average
calculating circuit 17 and the average $Dopb, 1$ for the
first line through the average $Dopb, n-1$ for the $(n -$
 $1)$ -th line, outputted from the latch circuit 30.
15 Then, the average calculating circuit 30 divides the
thus-obtained sum by n , that is, by the total number
of the averages $Dopb, 1$ through $Dopb, n$ inputted to the
average calculating circuit 30.

When $n = 1$, the moving-average portion 29
20 outputs the inputted average $Dopb, 1$, as it is, as the
black reference value $Db, 1$.

When comparing the first embodiment, shown
in FIGS. 3 and 4, with the second embodiment, shown in
FIGS. 5 and 6, the first embodiment is superior for
25 the following reasons.

1 In the second embodiment, it is necessary to
increase the number ($m + 1$) of the averages $Dopb, n-m$
through $Dopb, n$ (the average Db, n of which averages is
used as the data of the black reference level to be
5 subtracted from the data $D0$ of the image signal in the
black shading correction), in order to increase the
accuracy of the data of the black reference level used
for the black shading correction, that is, in order to
increase the accuracy of the value Db, n to be
10 subtracted from the data $D0$ of the image signal so as
to eliminate the black offset from the image signal.
For this purpose, a large number of registers are
needed, and, as a result, the size of the entire
circuit increases. Further, in this case, because the
15 number ($m + 1$) of the averages $Dopb, n-m$ through $Dopb, n$
(the average Db, n of which averages is used as the
data of the black reference level) increases, it is
not possible that the black shading correction well
follows the variation in the black offset level.

20 In order to enable the black shading
correction to well follow the variation in the black
offset level, it is necessary to reduce the number (m
 $+ 1$) of the averages $Dopb, n-m$ through $Dopb, n$ (the
average Db, n of which averages is used as the data of
25 the black reference level). However, in this case,

1 the accuracy of the data of the black reference level
decreases. Thereby, it is not possible to
sufficiently reduce the influence due to a bad S/N
ratio of the image reading apparatus on the data of
5 the black reference level used for the black shading
correction. For example, it is merely possible to
reduce the variation due to the noise by a factor of 2
or 3, although it is possible to reduce the variation
due to the noise by the factor of A in the first
10 embodiment as shown in the above-mentioned equation
(3), where the constant A can be adjusted
appropriately.

Thus, although the arrangement, such as that
in the second embodiment, in which the data of the
15 black reference level is obtained through the moving-
averaging in the sub-scan direction of the averages,
each being the average of the pixel values of the OPB
portion in the main scan direction, is possible, the
arrangement, such as that in the first embodiment, in
20 which the black reference level is obtained through
the weighted-averaging in the sub-scan direction of
the averages, each being the average of the pixel
values of the OPB portion in the main scan direction,
is superior.

25 Thus, as a result of the weighted-average or

1 the moving-average of values, each of the values being
data of the shielded portion (OPB portion) of the
photoelectric device for a respective line, being used
as the data of the black reference level used for the
5 black shading correction, it is possible to control
the variation in the level of the image signal for
each line due to the variation in the black reference
level used for the black shading correction for each
line due to noise, and, also, it is possible to enable
10 the black shading correction to well follow the
variation in the black offset level of the image
signal due to variation in the level of the image
signal, for each line.

The present invention is not limited to the
15 above-described embodiments, and variations and
modifications may be made without departing from the
scope of the present invention.

The present invention is based on Japanese
priority application No. 10-296061 filed on October 2,
20 1998, the entire contents of which are hereby
incorporated by reference.

1 WHAT IS CLAIMED IS

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1. An image reading apparatus, comprising:
photoelectrically converting means for
photoelectrically converting image information
obtained from optically reading an original image,
10 line by line, and outputting an image signal, said
photoelectrically converting means having optically
shielding means provided at a portion thereof; and
black shading correcting means for
correcting the image signal using a black reference
15 level, said black reference level being obtained from
said portion of said photoelectrically converting
means for each line during an operation of the reading
of the original image,

wherein the black reference level used by
20 said black shading correcting means for each line is
obtained using black reference values, each of the
black reference values being data of said portion of
said photoelectrically converting means for a
respective one of a plurality of lines.

25

1 2. The image reading apparatus, as claimed
in claim 1, wherein the black reference level is a
weighted average of the black reference values.

5

3. The image reading apparatus, as claimed
in claim 2, wherein the black reference value for a
10 respective line is an average of pixel values in a
main scan direction, and the weighted average of the
black reference value is obtained from weighted-
averaging, in a sub-scan direction, the black
reference values.

15

4. The image reading apparatus, as claimed
20 in claim 1, wherein the black reference level for each
line is obtained from weighted-averaging the black
reference value for the current line and the black
reference level for the preceding line.

25

1 5. The image reading apparatus, as claimed
in claim 1, wherein the black reference level is a
moving average of the black reference values.

5

6. The image reading apparatus, as claimed
in claim 5, wherein the black reference level for a
10 respective line is an average of pixel values in a
main scan direction, the moving average being obtained
from moving-averaging, in a sub-scan direction, the
black reference values.

15

7. The image reading apparatus, as claimed
in claim 1, wherein the black reference level for each
20 line is obtained from moving-averaging the black
reference values for the plurality of lines.

25

1 8. The image reading apparatus, as claimed
in claim 7, wherein the plurality of lines comprise
the current line and preceding lines.

5

9. An image reading apparatus, comprising:
a photoelectric unit which photoelectrically
10 converts image information obtained from optically
reading an original image, line by line, and outputs
an image signal, said photoelectric unit having an
optically shielding member provided at a portion
thereof; and
15 a black shading correcting unit which
corrects the image signal using a black reference
level, said black reference level being obtained from
said portion of said photoelectric unit for each line
during an operation of the reading of the original
20 image,

wherein the black reference level is
obtained using black reference values, each of the
black reference values being data of said portion of
said photoelectrically converting means for a
25 respective one of the plurality of lines.

1 10. The image reading apparatus, as claimed
in claim 9, wherein the black reference level is a
weighted average of the black reference values.

5

10 11. The image reading apparatus, as claimed
in claim 10, wherein the black reference value for a
respective line is an average of pixel values in a
main scan direction, and the weighted average of the
black reference values is obtained from weighted-
averaging, in a sub-scan direction, the black
reference values.

15

20 12. The image reading apparatus, as claimed
in claim 9, wherein the black reference level for each
line is obtained from weighted-averaging the black
reference value for the current line and the black
reference level for the preceding line.

25

1 13. The image reading apparatus, as claimed
in claim 9, wherein the black reference level is a
moving average of the black reference values.

5

10 14. The image reading apparatus, as claimed
in claim 13, wherein the black reference value for a
respective line is an average of pixel values in a
main scan direction, the moving average being obtained
from moving-averaging, in a sub-scan direction, the
black reference values.

15

20 15. The image reading apparatus, as claimed
in claim 9, wherein the black reference level for each
line is obtained from moving-averaging the black
reference values for the plurality of lines.

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1 16. The image reading apparatus, as claimed
in claim 15, wherein the plurality of lines comprise
the current line and preceding lines.

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1 ABSTRACT OF THE DISCLOSURE

 A CCD photoelectrically converts image
information obtained from optically reading an
original image, line by line, and outputs an image
5 signal. Several of the photoelectric sensors of a CCD
of the CCD portion form an optical black portion. A
black shading correcting portion corrects the image
signal using a black reference level. The black
reference level is obtained from the optical black
10 portion of the CCD for each line during an operation
of the reading of the original image. The black
reference level used by said black shading correcting
portion for each line is obtained using black
reference values, each of the black reference values
15 being data of the optical black portion for a
respective one of a plurality of lines.

20

25

FIG. 1

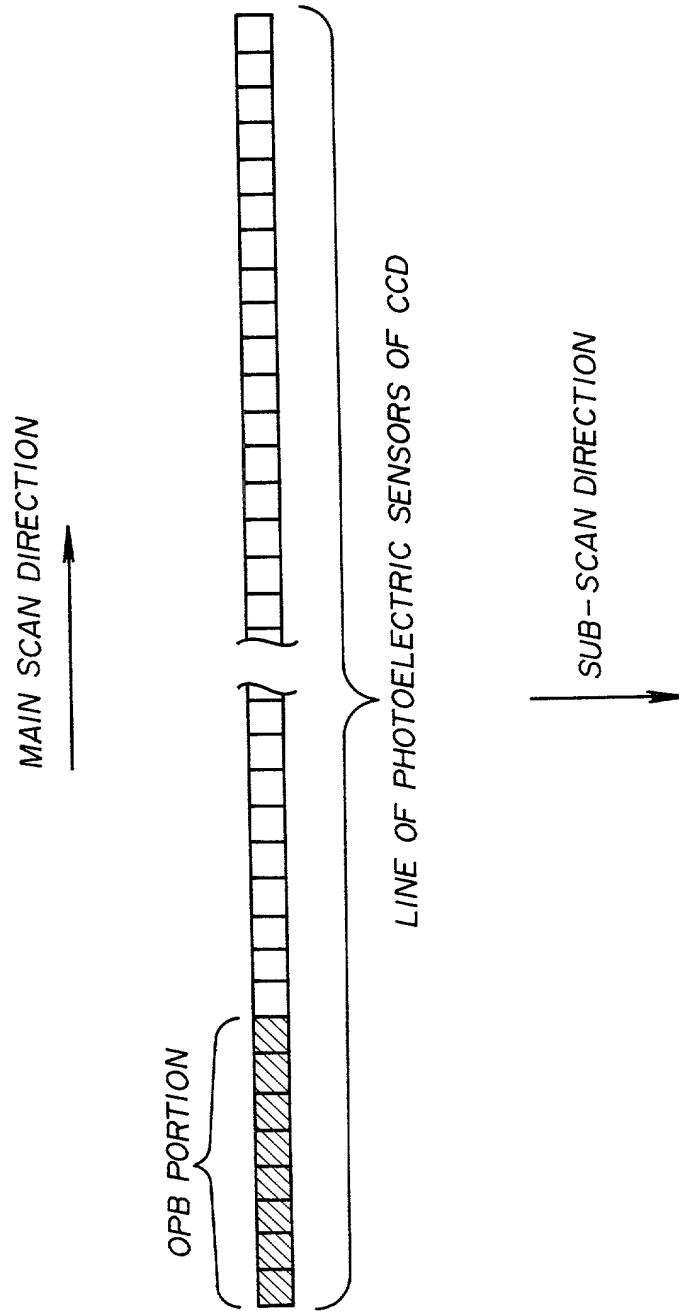


FIG. 2

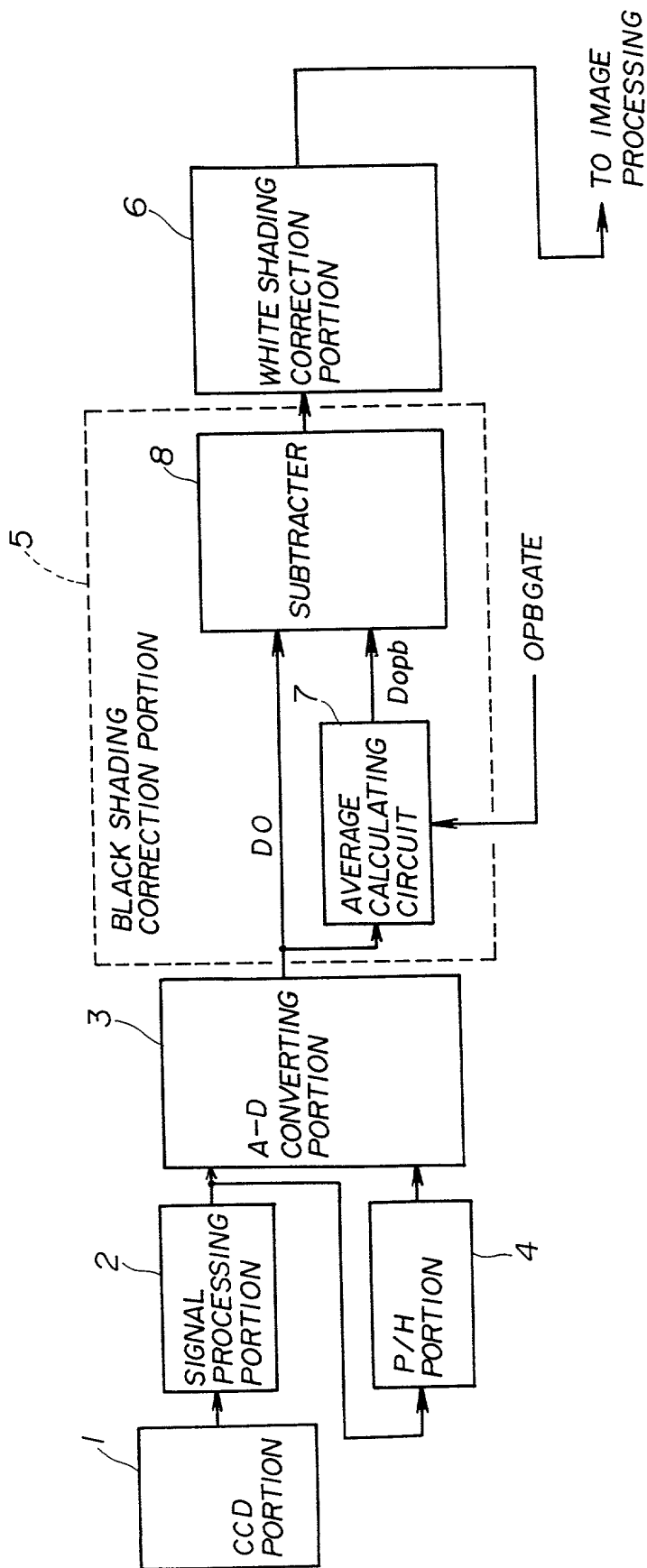


FIG. 3

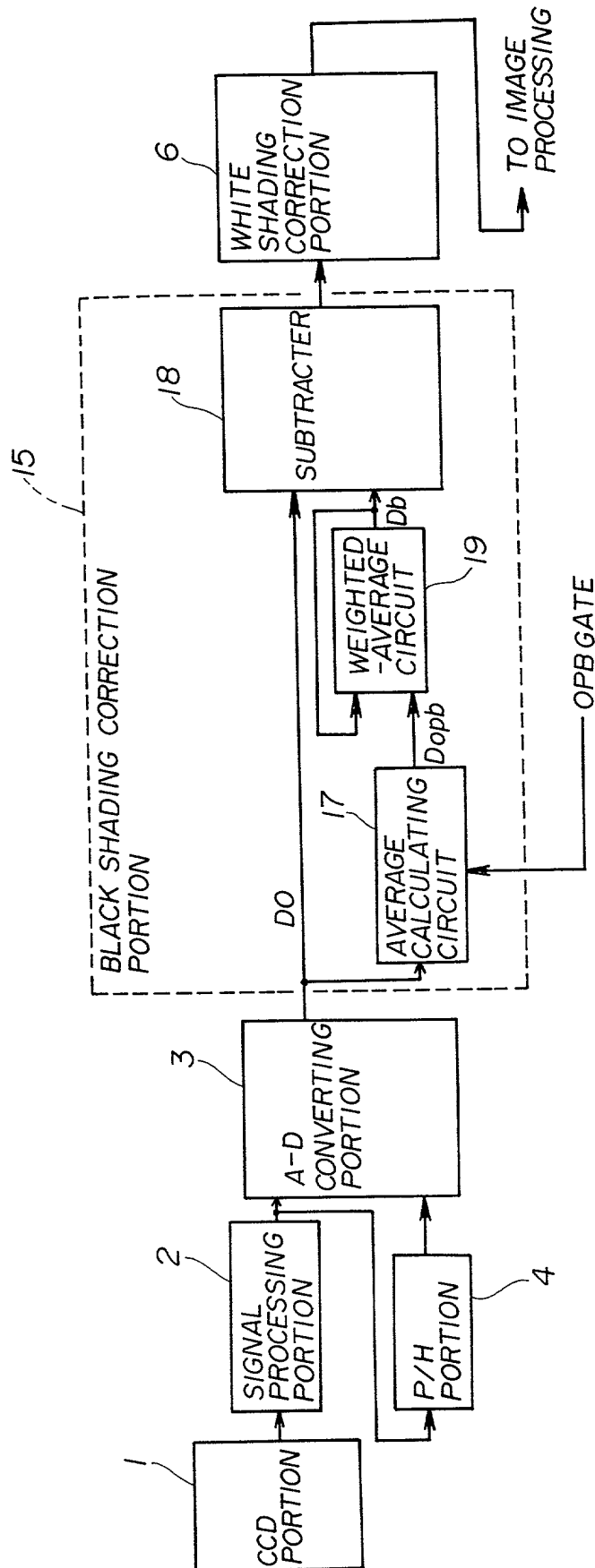


FIG. 4

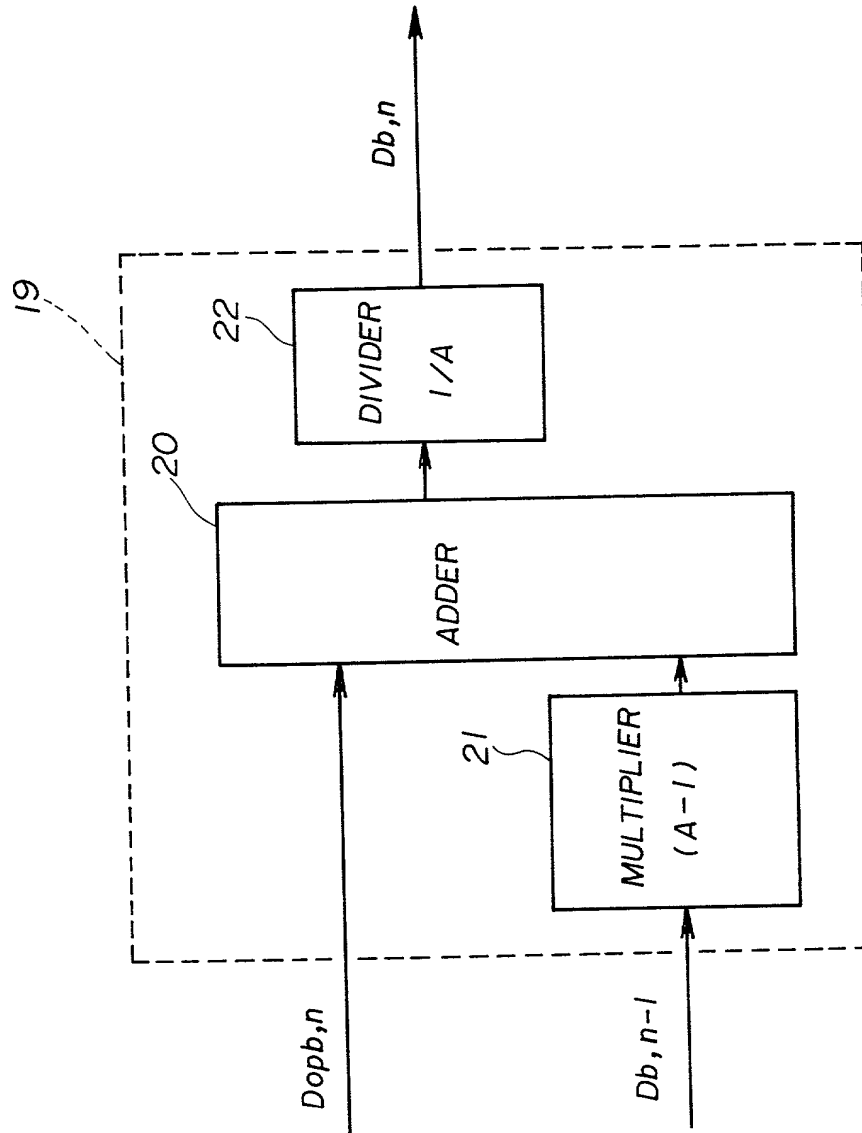


FIG. 5

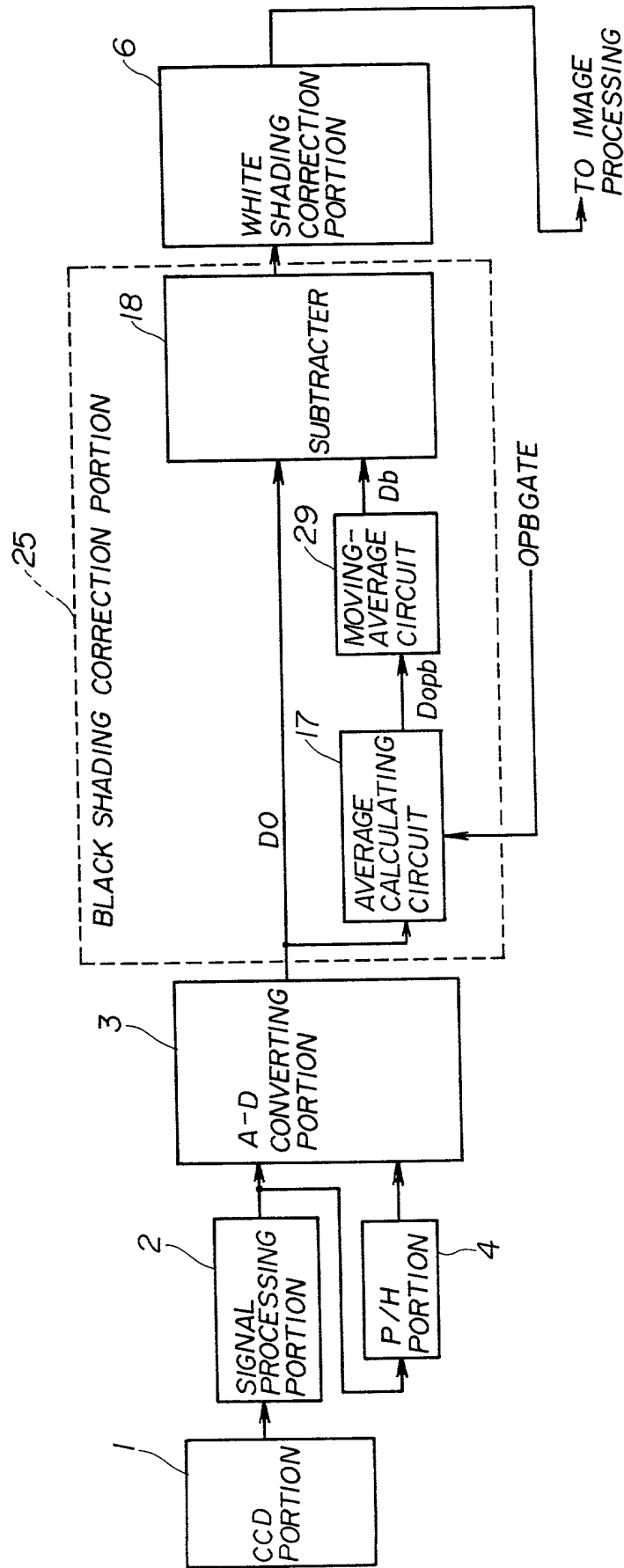


FIG. 6

